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ABSTRACT

TEACHING SUGGESTIONS FOR ENVIRONMENTAL EDUCATION IN INTERMEDIATE GRADES ARE GROUPED UNDER FOUR GENERAL HEADINGS: "GEOLOGY," "SOIL CONSERVATION AND LAND USE," "TREES, WOODLOTS, AND FORESTS," AND "WILD-LIFE AND FISHES." LISTED UNDER EACH HEADING ARE ATTITUDES AND UNDERSTANDINGS TO DEVELOP, TOPICS FOR DISCUSSION, AND MANY SUGGESTED ACTIVITIES. ACTIVITIES REQUIRE STUDENTS TO MAKE OUTDOOR OBSERVATIONS, COLLECT NATURAL SPECIMENS, USE REFERENCE MATERIALS, AND PERFORM SIMPLE EXPERIMENTS. SUGGESTIONS ARE MADE FOR FIELD TRIPS. THE BIBLIOGRAPHY LISTS REFERENCES FOR TEACHERS AND STUDENTS RELATED TO EACH OF THE FOUR GENERAL TOPICS, AND INCLUDES CHARTS, MAPS, BULLETINS AND PAMPHLETS AS WELL AS BOOKS. (EB)

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ENVIRONMENTAL EDUCATION for INTERMEDIATE GRADES

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A Teacher's Manual

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MICHIGAN DEPARTMENT OF NATURAL RESOURCES

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INTERMEDIATE GRADES

Geology: Rocks, Air, Water and other Minerals

ATTITUDES AND UNDERSTANDINGS TO DEVELOP:

1. Geology is earth history. The earth has a history just as you, your school, your town, your country have histories - past, a present, and a future. Rocks tell the story of the earth.

2. The earth is more than three billion years old, but the processes of change that started when the earth was young are still going on everywhere, all the time.

3. With knowledge of earth history, we can develop a better understanding of our modern way of living, of our agriculture, our industry, our recreation, and our culture.

4. Knowledge of geology has made it possible to locate deposits of vital minerals and rocks necessary for modern society. "The minerals of the earth are the prime necessity for war and peace."

5. Earth history is engrossing, and we can study phases of it anywhere.

6. Geology is a sound basis for study of conservation - literally from the ground up. (Note geology in Soil Conservation and Land Use).

7. The earth is continually changing.

8. Most changes in the earth and on its surface occur slowly through hundreds and thousands of years. Earthquakes, volcanic activity, cave-ins, floods, and shore erosion are rapid changes.

9. Heat and cold, wind, moving water, moving ice, and men are agents that change (weather) the face of the earth.

10. The earth is made of rocks. Rocks are made of minerals.

11. Weathering changes rocks and releases minerals.

12. Minerals are basic plant food. Life would be impossible without them.

13. Minerals are metallic--gold, silver, iron, and others; and non-metallic--salt, gypsum water, and others.

14. Minerals are nonrenewable resources, or, Nature renews them so slowly that they do not become available for man's use.

15. Use of mineral resources has given America its high standard of living and our leisure time.

16. Food comes from renewable resources--plants and animals. Animals live upon plants, plants live upon the minerals in the earth and some of the gasses in the air. Shelter and clothing come from nonrenewable as well as renewable resources.

TOPICS FOR DISCUSSION:

1. What is air? What is wind?

2. What are clouds? Why do they float across the sky?

3. Water is a mineral. Discuss the three forms of water: vapor, liquid, solid.

4. Discuss ground water in relation to surface water.

5. Discuss the competing uses of water: domestic, irrigation, industry, recreation.

6. Discuss clean water and polluted water. What are the sources of pollution? Explain the need for reusing water. Show movie, "The River Grand", available from the Department of Natural Resources.

7. Discuss the major sources and effects of air pollution.

8. Are there any state or municipal laws to curb air pollution? How effective are they? What state agency is responsible for trying to prevent serious pollution?

9. Discuss the effects of wind, raindrops, and running water on rocks and soils.

10. Explain how lichens, mosses and other plants dissolve rocks or break them up.

11. Describe the effects of heat and cold on rocks.

12. Discuss fossils found in Michigan rocks.

13. Explain the difference between igneous rocks, stratified rocks, metamorphic rocks. Which are the oldest rocks in Michigan?

14. Review the geologic periods represented in the rock formations of Michigan. What was the climate during each period; the vegetation and animal life of each period? How long did each period last? How do we estimate or determine the age of rock strata?

15. Discuss dinosaurs. What happened to them?

SUGGESTED ACTIVITIES:

1. Watch water evaporate in a flat glass dish. Discuss what happens to the water. Discuss what is left in the dish. Relate this experiment to evaporation from oceans, lakes, rivers, soil. Draw pictures illustrating the hydrologic cycle.

2. On a snowy day, examine snowflakes under a hand lens. It is advisable to let the snowflakes fall on some dark material. Snowflakes are water crystals. Water is a mineral. Notice that the snowflakes are six-sided crystals. A good follow up is to allow the children to cut paper snowflakes. Use ice crystals formed in a refrigerator unit when there is no snow.

3. Do farmers like snow? Discuss snow on a farm, in a city. What about rain?

4. Fill a pan with snow. Guess how much water will be in the pan when the snow melts. Pack the snow. Discuss what happens. Place a deep container where rain will fall freely, not splatter, into it. Measure the water in the container after a rain.

5. For an arithmetic lesson, compute the amount of water that fell as snow on your school ground. Compute the amount of water that fell on the school ground during a rain.

6. Make crystals. Dissolve powdered alum in hot water. (Bring water to the boiling point, turn off heat, add alum slowly until no more will dissolve.) Suspend a string in the water and set aside to cool. If a Pyrex dish or a glass

beaker is used, the children can watch the formation of the crystals. Nature makes crystals from hot and cold rock liquids in the earth.

7. Find some rocks with crystals and compare with the alum crystals. If you are near a museum, visit the mineral collection and study the crystals. Use models of geometrical solids in discussing crystals.

8. Watch icicles form. The icicles are made of tiny crystals of water (ice).

9. Salt is a mineral. Examine table salt under a hand lens. What is the shape of a salt crystal? (cube shaped) How is salt used in your home? Find other uses for salt.

10. Of what is your schoolhouse made? If it has a stone foundation, examine the stone. Examine the gravel in the road or schoolyard. Is it like the salt or alum crystals? If your schoolhouse is brick, from where did the bricks come? Brick is an artificial rock. Find out from what bricks are made. Cement and concrete are artificial rocks. What are they made from?

11. Rock is made of mineral crystals locked tightly together. Some rocks have only one mineral. Others have several minerals. Visit a gravel pit and collect rocks of each type.

12. Examine the sidewalks near your school. Are the edges smooth and firm? Hard surfaced roads and sidewalks are man-made artificial rocks and nature treats them just as she does the rocks she makes herself. If the edges of the walk are broken, discuss how it happened (heat and cold, tree roots, people walking). Discuss what will happen to the broken pieces when the next rain comes. Notice how the land slopes from the sidewalk. Will the slope have any effect on what happens to the rainwash? The same forces that break up the pavement break up natural rocks. The broken up sidewalk (rock) particles are weathered rock. When picked up and moved by rainwash and settled somewhere else, they are sediments, and they will harden into another rock. (See Soil Conservation and Land Use activities: Nos. 9–11).

13. To show what happens to sediments, mix sand with water, spread on a flat dish, let water evaporate. Notice how hard the sand gets and that it cracks. Such cracks in rocks are called joints.

14. Try the experiment with clay, with muck, with lime. Vary the experiment by evaporating near heat, with a fan blowing hot or cold air.

15. Drop some vinegar on the lime. Discuss what happens. Try the vinegar on other rocks and see if they will fizz. Better, obtain some 10% hydrochloric (muriatic) acid from a drug store for this experiment. Vinegar does not always work. Gather some snail and/or clam shells. Try the experiment on them. Try it on bones. Lime is used by animals to build their shells and bones. When they die in the sea, shells of sea animals sink to the bottom and become buried in the lime mud. After a long time, they are changed to stone (petrified) and we then call them fossils. Some plants also take lime from water and build masses of lime mud that becomes rock. Some plat-deposited lime is marl.

16. Make a sand table. Pile a mixture of sand, gravel, lime, clay on the table. Let water drop through the mix. Note changes. Vary the incline of the table and see what happens. Vary the rate of water flow. Compare results. Discuss erosion. If you can get a piece of sod, cover the sand, gravel, clay pile with it and repeat the experiment. If you cannot get the sod, a couple layers of blotting paper can substitute.

17. If you can arrange your sand table so that the sediments are washed into a glass–sided sink or aquarium, you can see the deposition of the sorted sediments––gravel, sand, clay, lime, and all sorts of mixtures, and explain to the children that that is the way sedimentary rocks are made––the gravel becomes conglomerate; sand becomes sandstone; clay or silt becomes shale; and lime, limestone.

18. Compare with the work of streams in the vicinity. Compare with the work of rainfall or snow–melt on the school grounds.

19. Fill a fruit jar half full of water. Put sand and pebbles of several small sizes into it. Shake the jar. Notice how the material separates into layers. Add some clay or chalk dust. Shake the jar again; discuss what happens. Sediments deposited by rivers are in similar layers. We call each layer a stratum; several are strata; and when the deposits have the water squeezed out and become rock, they are called stratified sedimentary rocks.

20. Do you have a coal furnace? Have you ever seen a clinker in a coal furnace? That is mineral matter which has been melted in the heat of the furnace.

    Mineral matter that has been heated in the earth is called igneous or fire rock. When it cools, the various minerals crystallize as the alum did, or as fudge does. If it cools slowly, the crystals are large. If it cools rapidly, fine crystals are formed. If it cools very rapidly, the rock is glassy and no crystals can be seen except with a very highpowered microscope. Such rocks are called igneous, crystalline, and commonly, granite. They are the oldest rocks and were weathered to form the sediments and they are really the parents of the sedimentary rocks.

    Nature changes rocks. In some places she melts them just enough so the crystals can get together in bands. In other places, the rocks are baked harder--like the slate of your blackboard that was once a clay mud. The rocks that are changed from one form to another are called metamorphic or changed rocks (granite to gneiss; sand to sandstone and quartzite; clay to shale to slate; and lime to limestone to marble). In the winter, pack snow. Note the changes. Actually the soft crystals have been changed by hand pressure into rock--ice; an example of a metamorphic rock.

21. Take a trip in your town and see how many buildings are made of stone. See if you can determine the kind of stone: granite, slate, limestone, marble, shale, sandstone. Did it come from your locality? Did the marble in the bank come from your town?

22. Take a trip to a gravel pit. See how many different kinds of stones you can find. Note if any of the stones have fossils in them. Discuss fossils. How did so many different kinds of stones get together?

23. Break a rock. Note the difference between the old and the fresh surface. Discuss the reason for the difference and if it has any relation to our food supply.

24. Find a rock with lichens or mosses growing on it. Discuss how the plant is breaking up (weathering) the rock and how soil will be made when the plant dies and mixes with the broken rock.

25. If a quarry is in your neighborhood, get permission to visit it. Collect rocks and stones found there. Discover fossils. Note vegetation. Count the numbers of plant species. Note any evidence of animal habitation.

26. Find someone who can tell you the history of the quarry or gravel pit. How does the quarry or gravel pit benefit your community?

27. Write a story about the quarry or gravel pit for your social studies or English class.

28. Study the history of iron and copper mining in Michigan. On a map of the state, indicate the areas where iron and copper are mined.

29. Michigan has the largest limestone quarry in the country. Where is it located? What is limestone used for? List its uses. Where is it shipped? What other areas of the state produce limestone?

30. Locate the gypsum deposits and quarries on your map of Michigan. How does gypsum differ from limestone?

31. What is Portland Cement? How and where is it manufactured?

32. Is gravel an important natural resource? How important? (Information on the foregoing mineral resources will be found in Michigan's Mineral Industries Reports of the Geological Survey Division of the Department of Natural Resources.)

33. View TV films dealing with gypsum, limestone, salt, iron and copper mining, available from Film Loan Service, Department of Natural Resources. Write for a catalog listing titles.

34. After a heavy rain, note the effect of the water on the school yard. Notice the effect on baseball fields, grass plots, along sidewalks, and on tree areas.

    For a math lesson, measure the rainfall. Compute the amount of rain on the school property. Be sure the container is placed where rain can only fall, not splatter or fall from roofs into it.

    Make a sand table display showing streams, industries located on their banks which make use of the water, recreational values where streams are used by fishermen, campers, picnickers. How do industrial wastes affect the fisherman, camper, and picnicker? Find out what is being done with the industrial wastes from the industries of your town.

35. Watch the cloud changes when the weather bureau forecasts a storm. Draw pictures of different types of clouds in the order in which they appear in the sky before and after a rainstorm. Keep a record of cloud changes for a day, a week, a month. Keep a record of the weather for the same time. Discuss relationship.

36. Visit a weather bureau if one is available.

37. Set up a miniature weather bureau in your room. Make a simple barometer (directions are found in most general science books) and keep a record of changing weather conditions. From a study of barometric changes, clouds, and wind direction, see if you can make a weather prediction. Try this after three or four days' observation.

38. From your nearest local weather bureau, find the average annual rainfall for different sections of the state. Find out how much water soaks into the ground; how much runs to lakes and streams; how much plants use; how much plants transpire. Many problems in arithmetic can be evolved from such data: Compute the amount of water used in preparing your dinner.

39. Study the source of the water supply of your school. Study relation of water to plants, people, preparation of food, and industry.

40. Have some of the community's water tested.

41. Visit a purification plant, reservoir, sewage disposal plant, or other public utilities connected with water supply.

42. Find out how much water is used by industry in your town. After being used, where does it go? Do any industries reuse water?

43. Visit a lake at various seasons of the year to evidence important geological changes that take place. Note the effect of the ice on the shoreline plant growth, on the lake bottom; wave action, and other effects.

44. Investigate the source of your community's water supply. Find out the amount used per capita per day. List all the uses of water in your home, in your community. Have each pupil determine how water has been of value to him in one day.

45. Discuss causes of water pollution. Both ground water and surface water can be, and are, polluted in some areas. Discuss methods of remedying water pollution. Discuss the disposal of industrial wastes in your community.

46. If local water supplies are from individual wells, map your community to show well depth and quality. Include the amount pumped from each well per day.

47. Visit an oil field if possible. Find out what type of rock is most likely to yield oil. Write the fascinating story of how oil came to be in the rock and the relationship between old seas that covered the state, the plants and animals that lived in them, and petroleum.

48. Find what laws we have regarding the flow from an oil well and why they are good laws.

49. Determine why a law was written to prohibit oil well drillers from abandoning a well without first plugging or casing the hole thoroughly. Investigate the relationship this has to a water supply.

50. Chart the uses of Michigan's rocks and minerals; or prepare reports on the various minerals found in the state. Bring out economic and social significance of the discovery and the processing of these minerals.

51. Discuss and chart the uses of water in agriculture, manufacturing, recreation, transportation, and for domestic purposes. In the same way, discuss and chart the uses of iron, copper, salt, bromine, gypsum, gravel, limestone. Did primitive man use any of these resources?

52. How has geology——earth history——affected your community? its location? its industries?

53. Discuss the effect of mineral resources of Michigan on the history of the United States.

54. Discuss the origin of the Great Lakes and the relation of the Great Lakes to United States history and economy.

55. Outline the history of your town. What influenced its location? What were its first industries? What are its industries now? Why the change? Discuss the part, if any, played by minerals in the change. Determine if the local water supply had anything to do with industries coming to, or moving from, your town.

56. On a field trip, carry a map and locate various glacial features, such as moraines, till plains, boulder clay, gravel deposits. Account for the many different rocks and soil types found in a small area. Discuss good land uses of these glacial deposits.

57. Make a large map of the county, showing important geological features, such as streams, direction of stream flow, lakes, general moraine, ground moraine (till plain) areas, and outwash plains. Avoid having the map become too intricate. Note relation of agriculture or other land use to the geological formations. Note the relation of ecology and geology.

Soil Conservation and Land Use

ATTITUDES AND UNDERSTANDINGS TO DEVELOP:

1. Soil is a living thing.

2. It is born of many parents——minerals and sunshine, water and air, heat and cold.

3. It lives, grows, and sustains life. And it can die.

4. It is made up of tiny particles of rock, refined and mellowed by the ages.

5. It adds to itself remains of plants and animals to make a home and food for millions of minute forms of life and in so doing, adds to its own life and productivity.

6. Soils differ depending on the influence of each parent. Some are best adapted to growing corn, some potatoes and some peaches.

7. Man is master of the soil. With good care he can make it yield large returns, or he can destroy it by carelessness and neglect.

8. Land is soil, lakes, rivers, forests, and even climate and location.

9. Each combination is a land type and best suited for certain uses according to man's need.

10. Land use is the study, determination and putting of land to that use most beneficial to man.

11. Land use can also mean good management and care of soil, water, forests, and associated resources that make it the land by which we live.

12. America cannot be proud of many things we have done to our land.

13. Some of our forests have been wasted and burned.

14. Some land has been cleared and farmed that should have remained in forests.

15. Much of our farm land has been abused, misused, and made barren.

TOPICS FOR DISCUSSION:

1. Discuss top soil and subsoil. What is humus? How is it formed? Why is it important?

2. Discuss the occurrence and importance of air and water in the soil.

3. Discuss the various kinds of soil: sand, loam, clay. Which retains the most water that is available to plants? Why? Which is the least fertile?

4. Discuss how plants and animals increase the fertility of the soil. Include earth worms and other animal life that live in the soil, bacteria, fungi, and decaying plant and animal material. Read "Life in the Soil" available from the Department of Natural Resources.

5. Discuss the necessity of farms to all of us, no matter where we live.

6. Discuss methods of preventing soil from becoming unproductive due to loss of mineral content. Find out about crop rotation, alfalfa, and other legumes which add nitrogen to the soil; use of commercial fertilizers; etc.

7. Discuss the uses of land other than agriculture. Examples: state, national, and private forests; state, county, and municipal parks and recreation areas; forest campgrounds, highways, airports, factory sites, towns, cities, and suburban developments, swamps, marshes, lakes, streams, and wastelands.

8. Show film "Yours Is The Land", available from the Department of Natural Resources.

9. Discuss soil erosion. Explain the effects of wind and water on unprotected soil.

10. Discuss the importance of vegetation (trees, shrubs, grass, weeds, and wild and cultivated plants) in preventing soil erosion.

11. Explain the meaning of the following terms: a/ contour plowing, b/ strip cropping, c/ gulley erosion, d/ sheet erosion, e/ sod waterways, f/ windbreaks, g/ legumes, h/ grass farming, and i/ row crops.

12. List some of the reasons why it is important to prevent soil erosion.

13. Explain how livestock, especially sheep and cattle, can induce erosion in pastures and on rangelands. (By overgrazing, making paths which start gullies, and by breaking down stream banks.)

SUGGESTED ACTIVITIES:

1. Take a field trip to a wooded area to see the formation of humus by the decaying leaves and other organic matter.

2. In lieu of a trip to a wooded area, gather leaves in the fall. Place them in a shallow container over a layer of earth. Keep the leaves moist. Notice how the leaves decompose. This will give an example of how humus is added to the soil.

3. Draw pictures or build on the sand table, an example of a farm whose owner takes good care of his land.

4. (Soil Erosion––the wearing away of soil by wind and water.) Find where the water has made ditches in hillsides or road banks. Notice the way water has cut into the soil. Notice the delta that has been built up at the mouth of the ditch (gully). Little ditches and big ditches all act the same way. Rivers are ditches that have water in them the year around.

5. After a rain, visit a hill that is covered with grass. Visit another hill that has been plowed. On which hill are you apt to find more examples of erosion by water?

6. If the preceeding suggestion is impractical, build two mounds of soil in the schoolyard.Cover one with sod. Let the other remain packed down, but unsodded. Use a sprinkling can or a tin can with holes punched in the bottom. Sprinkle water on the two mounds. Have the children pretend the mounds are actual hills and the water is actual rain. Which hill is apt to show the most erosion? Why is this so?

7. Demonstrate how soil particles are formed by rubbing a piece of sandstone on a harder rock. This represents the wearing away of rock by glaciation.

8. Discuss the effect of a sand blaster on the face of a stone building. Compare this to wind erosion.

9. Rock "weathers" away to form soil. Find a rock that has been exposed to the elements. If it is possible, break the rock. Notice the color on the inside is different from the outside. The outside of the rock is weathered. Weathering of rock makes soil.

10. Visit the sidewalk in front of your school. Do you see any cracks in the cement? Are there any places near trees where the cement is being pushed up and broken by the tree roots? Plants help break up rocks. The force of growing things exert tremendous pressure––enough to break rocks.

11. Find a rock that has lichens growing on it. Lichens are the very first form of plants that get their food from rock. Lichens produce acids that dissolve the rock; and, as the lichens move in, more rock is crumbled away, forming soil.

12. Find places where mud has washed over a field or sidewalk. Notice how fine this material is. Try to find out how far it was moved from its original place. (On gently rolling slopes, there is usually not as much evidence of gully erosion as there is sheet erosion. Sheet erosion moves almost imperceptibly, the top layer of fertile soil downward to the valleys.) In the valley where there is no evidence of a gully, see if you can find an accumulation of eroded soil. Sheet erosion damages as much land as does the more spectacular gully erosion.

13. Visit a stream in the spring. Notice the color of the water. Collect some of the water in a fruit jar; let it settle for several days. Notice the various layers of sediment. The finest material is soil being carried by the stream. If the finest material remains in suspension the longest, it will be carried farthest from the farm from which it came.

14. Find places where the wind has blown soil into drifts. Notice the color of the drifts. They are usually lighter in color than the surrounding soil. Collect some of the drift soil and collect some of the soil from a nearby field. Take them back to your classroom. Can you find out why one soil is lighter in color than the other? Try to grow some seeds in each kind of soil. What do you think has happened to the humus or organic matter in the drifted soil?

15. Illustrate how sod holds soil and water in place. Cut a six–inch square of good sod and bring it into your classroom. Have the children notice how the grass roots mat together. Try to pull out some of the grass. Notice that the soil clings to the roots of the plants. Notice that the soil is moist. From an open spot, bring in an equal amount of the soil. Compare the stability of the soil and the moisture of the soil. (Caution! Be sure to keep both samples as moist as they originally were when excavated.)

16. To exemplify the effect of contour plowing, build two mounds of soil. Make furrows in one mound going up and down the slope. Make furrows in the other going around the slope. Sprinkle with water. Which mound shows the greatest amount of erosion?

17. To illustrate what happens when a raindrop strikes bare earth, put some soil in a small baking tin. With an eye dropper, drop water from several feet above the tin onto the soil. Have the pupils watch to see the soil puff upward when the water hits it. Make a mound of this soil. Drop more water and see if any evidence of erosion takes place.

18. To illustrate run-off of a forest hillside compared to a bare hillside, use a piece of blotting paper and a piece of ordinary penmanship paper. Tip the two pieces of paper. Drop water on each. Notice how the blotter absorbs water (forested hillside) and how the water runs off smooth paper (bare hillside). Apply this to farming practices.

19. Some people in southern Michigan earn part of their money by trapping muskrats. Muskrat fur is quite valuable. Muskrats live in ponds or small lakes where they are able to build their houses and where they can get food. Having a habitat suitable for muskrat is another use of land.

    A. Visit a pond to see a muskrat house.

    B. Find out why muskrats build their houses where they do.

    C. What are some other animals that are hunted or trapped?

    Having suitable habitat for game or fur–bearing animals is good land use. Many thousands of dollars come into the various communities of the state each year because people hunt game birds or animals in these localities. In terms of land use, game is being harvested as a crop, and it should be considered as such.

20. Discuss other ways in which people make a living from the land:

    A. Agriculture (grain, fruit, truck crops, dairy cattle, beef cattle)

    B. Forestry (logging, saw mills, trucking, paper mills, furniture factories)

    C. Recreation (motels, restaurants, resorts, gas stations, sporting goods)

    D. Geology (iron, copper, gypsum, limestone, gravel, sand, petroleum)

    E. Commercial fishing

    F. Engineering

    G. Real Estate

Trees, Woodlots, and Forests

ATTITUDES AND UNDERSTANDINGS TO DEVELOP:

1. Trees are important; all of us depend upon them for health, comfort, and recreation.

2. People depend on many things which are made from trees.

3. A forest is a renewable resource.

4. The forest is a community of plants and animals in which trees are dominant.

5. Each kind of tree has special characteristics which enable it to live in certain environments but not in others.

6. Each kind of tree (and each family of trees) has its own peculiar structure and appearance: e.g. the shape, bark, wood, leaves and fruits of pines, spruces, elms, maples, oaks, etc. are all different in appearance and can be easily identified.

7. Trees influence soil, water, climate, wildlife, and man.

8. Trees also depend upon soil, water, climate, and wildlife.

9. Trees have many natural enemies: e.g. diseases, insects, wild animals, domestic animals, man, and weather.

10. The conservation of forests deals with the use and management of all woodland areas. They must be managed to serve a number of purposes (multiple use) because people depend on them for recreational as well as wood and wood products. Management involves reforestation, protection, and harvesting to serve these ends.

TOPICS FOR DISCUSSION:

1. Study the parts of a tree——roots, trunk, branches, buds, leaves, flowers, fruits.

2. Discuss the functions of each part of a tree or other plant and have children list them.

3. List things in the classroom that are made from wood. List the other uses of wood.

4. Discuss the ways in which the boys and girls can help prevent forest fires. Have children write a story about causes of forest fires and how they can be prevented.

5. Display "Smokey Bear" posters and dramatize "Smokey Bear". See reference list for script.

6. Discuss how trees are used as homes for birds and animals.

7. Discuss importance of nuts, seeds, and fruits for wildlife and man.

8. Discuss how forests helped or hindered the early settlers in Michigan.

9. View film "Timber Harvest", available from the Department of Natural Resources, and discuss various phases of logging operation.

10. Discuss forest trees in relation to the type of soils on which they usually grow. Consider pine, cedar, spruce, tamarack; oak and hickory; beech and hard maple; elm, ash, and soft maple.

11. Explain the concept of a forest as a community of plants and animals which is dominated by trees.

12. Explain plant succession in the development of a mature forest beginning with bare areas and progressing through the stages of pioneer species of plants, to shrubs and trees that will not reproduce in their own shade, to species of trees that are tolerant of shade and thus can maintain themselves indefinitely as a climax type of forest.

13. Explain how a tree grows. Illustrate by means of a colored chart on this subject available in free teacher's packet from the U.S. Forest Service, Regional Office, Upper Darby, Pennsylvania; or a similar packet issued by the American Forest Industries, 1816 N. Street N.W., Washington 6, D.C.

14. Discuss the forest regions of the U. S. and of Michigan utilizing chart in packets mentioned above.

15. Discuss useful products we obtain from trees. Refer to chart in same packets.

16. Show the film "Forests and People" and/or the TV film "Forests to Furniture", both available from the Department of Natural Resources.

17. Show the TV film "Forest Pests" and discuss with the class.

18. Other TV films recommended include: "Forests and Recreation", "State Forest Campgrounds", "Seeds, Seedlings, and Trees", "Maple Syrup Industry", etc.

SUGGESTED ACTIVITIES:

1. Find out what kind of trees grow in your yard at home, or in the school yard, or in some other convenient location. Make a list of them.

2. Make posters showing different trees——draw or cut out pictures to paste on posters; or mount pressed leaves on posters.

3. Collect leaves of different kinds of trees growing in vicinity of school or home. Learn the parts of a leaf--note different shapes, margin, veinings, surface texture, and color of both sides of leaf. Press leaves of different trees and mount them in a scrap book with accurate labels.

4. Learn to identify trees by appearance of leaves, bark, type of branching, etc.

5. Study the parts of a tree or other plant——roots, trunk, branches, buds, leaves, flowers, fruits, and discuss the functions of each part.

6. Find out which trees and shrubs change leaf color in the fall. Explain why leaves of some trees turn red and yellow in fall.

7. Decorate schoolroom with colored leaves.

8. Collect seeds, fruits, or nuts of different trees. Note winged seeds of maples, ash, and elm trees. If seeds have already fallen off some trees, they can often be found on the ground beneath the tree or nearby. Why do seeds of some trees have wings? Identify each of the winged seeds you find. Place some of each kind in small glass containers for display or future study.

9. Take a field trip to collect nuts. Learn to identify walnuts, butternuts, hickory nuts, hazelnuts, beechnuts, and acorns. Compare acorns from different kinds of oak trees.

10. Make sand table display of the school yard, home grounds, your farm, a local woodlot, or other suitable area showing location of trees, buildings, etc. Or, feature a lumber camp, fire tower, fire-fighting equipment, recreational opportunities. Develop idea of multiple use of land and forests.

11. Observe Arbor Day. Plant a tree or trees if practicable. Perhaps you can arrange to plant trees in the school forest or on a farm if none are needed in the school yard.

12. Discuss the various phases of lumber operations or dramatize scenes in a lumber camp.

13. Mount different kinds of twigs on cardboard and label each for display.

14. Make a collection of different kinds of cones of pines, spruce, firs, etc. Mount them on soft wallboard for display, or place in glass jars.

15. Obtain cross sections of a log and study annual rings in the wood. Count the rings in a stump to determine the age of a tree. Note any difference in the thickness of the annual rings. What can you conclude about weather (wet and dry seasons) from differences in thickness of rings. Note exceptions to rule that each ring represents a year's growth. A wet spring and dry summer followed by wet, warm weather in late summer and fall will sometimes result in a second period of rapid growth resulting in two rings for one year. Why are rings in tropical woods less evident or lacking? What factors besides weather affect the thickness of annual growth rings in wood? Discuss the relationship between the annual rings in a log and the "grain" in lumber made from that log.

16. Have students make a collection of different kinds of wood. Pieces of board 3"x5"x1/2" can be sanded, polished, and shellacked to show comparison of "grain" and color. These may be accompanied by cross sections of limbs of trees of the same species as the slabs of wood referred to above. Sections should be 3"x1/2" in size. Polish one cut surface and mount sample of lumber and end sections together for display.

17. Visit a forest or private nursery if possible and find out how trees are produced for forestry or landscaping purposes. Make arrangements with the supervisor of the nursery prior to the trip.

18. Visit a pine plantation or pine forest. Learn how to identify the different kinds of "evergreen" trees. Compare shape, length, sharpness, or bluntness, etc. of needles on different species. Note that in pines the needles are attached to the stem in clusters of two, three, or five; whereas in spruces, firs, and hemlocks, they are much shorter and attached singly. Note the scalelike needles of white cedar (arbor vitae). Compare cones of different species.

19. Note the whorls of branches on young white and red pine trees (trees up to 10–12 feet in height). Each whorl represents a year's growth. Why? Note the terminal bud at the apex of the main stem is surrounded by three or four lateral buds. New growth comes from the terminal bud and these lateral buds each spring. Do the branches also have terminal buds surrounded by lateral buds? How do jack pines differ from red and white pines in this respect? Can you tell age of jack pines by counting whorls of branches? Note any difference in distance between whorls of branches on red or white pines. Correlate these differences with wet or dry growing seasons, with other factors affecting rate of growth (soil type, soil moisture, overcrowded stands, etc.).

20. In older stands of pine (15-20 feet tall) note the difference between trees growing close together and those growing in open stands (far apart); or better yet, isolated trees. Explain why trees growing close together lose their lower branches and grow tall and straight. The same effect can often be seen in a grove or forest of deciduous trees (trees that shed their leaves).

21. Why is it good forestry practice to plant pine trees close together and then thin them out by selective cutting when they are large enough for pulpwood?

22. Visit a farm woodlot which has not been pastured. Notice such important items as the kind of trees, the relative abundance of the different kind of trees, spacing of trees, the abundance or scarcity and kinds of young trees which should eventually replace the mature trees after they are cut or removed by natural causes, the abundance and variety of herbaceous plants and shrubs in the woods and at the edge of the woods. Look for "den" trees, "wolf" trees, diseased or injured trees. Look for trees with fire scars near their bases.

23. Visit a pastured woodlot. Compare with the unpastured woodlot. Note difference in the amount of undergrowth. What will eventually happen to the woodlot which is permanently pastured? If possible, arrange with the Farm Forester, District Forester or some other resource person such as the District Game Manager, Conservation Officer, or County Agent to accompany the class on these field trips to woodlots and other forest areas. He can point out many things about forest management which might otherwise be overlooked.

24. While visiting woodlots and other forest areas, observe the amount of forest litter and humus on the forest floor. Discuss how trees and the litter of dead leaves and branches on the forest floor absorb rain water, slow down run–off, prevent erosion and help to prevent floods. Explain how forest litter builds up the soil.

25. Look up the history of forests and logging operations in your community or county. Are there any ghost towns in your county? If so, study their history and discuss why some towns survived and prospered after the forests were cut, and why others failed.

26. Prepare reports on the history of Michigan's lumber industry.

27. Prepare maps of your community, comparing the extent and location of forests before logging and clearing, and as they exist today.

28. Learn to identify the shrubs, trees, vines, and wildflowers that are protected by law in Michigan.

29. List other plants that are so scarce that they should not be picked. Circular available from the Department of Natural Resources.

Wildlife And Fishes

ATTITUDES AND UNDERSTANDINGS TO DEVELOP:

1. Animals as well as plants are products of the land.

2. Wildlife and fishes are affected by many environmental factors such as climate, soil, water, vegetation, and other wild or domestic animals, and man.

3. No individual or species can escape the pressure exerted by the physical and biological factors which are operative in its habitat.

4. Each species which lives in a given unit of habitat, whether it be a soil organism, insect, amphibian, reptile, fish, bird, or mammal, occupies a unique ecological niche in the wildlife community.

5. Competition for food, cover, and living space between species and individuals of the same species becomes intense in any animal community, and a complicated system of checks and balances (often called the "balance of nature") serves to keep each species from getting out of control and becoming too abundant.

6. Animal communities differ to the extent that their habits differ, and these differences may be very obvious or almost imperceptible.

7. The animals of any ecological community are adapted morphologically and physiologically to the physical, biological, and climatic conditions of their habitat.

8. Most animals (including fishes) are extremely sensitive to any changes in their environment; and, as a result, wildlife populations fluctuate, sometimes violently in response to seasonal and long–range variations in climate and changes in their habitat due to the effects of fire, wind, water, and the activity of man.

9. Man may alter the composition and abundance of a wildlife population by changing, destroying, or managing its habitat.

10. Man may introduce new species into an area with results that are harmful, or beneficial, or have little obvious effect.

11. Man's use of the land (including lakes and streams), his clearing and burning, draining and flooding, grazing and crop production, urbanization and industrialization have wrought great changes in the composition and abundance of wildlife populations. As a result, some species have become extinct, some scarce, and others more abundant.

12. Man can manage wildlife habitats for the benefit of desired species, sometimes at little cost in time, effort and money; but in other cases, at considerable cost.

13. Predatory species generally do more good than harm because they prevent their prey from becoming over-abundant and thus, tend to maintain the so–called balance in nature.

14. Every unit of land and water (habitat) has a limited capacity in providing food, cover, and living space (carrying capacity) for fish and wildlife. This carrying capacity can sometimes be increased if we improve the habitat; and thus, insofar as practicable, remove the limiting factors.

15. Hunting and fishing are legitimate recreational pursuits if properly regulated because most species of game and fish produce more young in favorable breeding seasons than their habitats will support.

16. Hunting and fishing regulations (laws governing open seasons, bag limits, creel limits, and methods of taking) are designed to insure an orderly harvest and to remove only the annual surpluses of game and fish without depleting the breeding stock.

TOPICS FOR DISCUSSION:

I. Discuss and explain the concepts and understandings listed above.

2. Explain why birds and animals must have food and cover at all seasons of the year. Emphasize the fact that different kinds of birds and animals differ in their habits and therefore differ in their food and shelter requirements. Illustrate by discussing the life history and habits of typical birds or animals such as pheasants, quail, ruffed grouse, squirrels, rabbits, deer, etc.

3. List birds, mammals, and other species of animal life that are usually found in the following habitats: forests and woodlots, open grasslands and wastelands, farm fields, marshes and swamps, lakes and streams.

4. The following birds and mammals are not protected by state or federal laws: crows, bronzed and purple grackles, cowbirds, starlings, and English sparrows; foxes, coyotes, weasels, porcupines, opossums, red squirrels, gophers, common rats, mice, shrews, moles, etc. Are all the species on the "no closed season" list harmful? Do they have good as well as bad habits? Have students study and list their good and bad habits. Does the good out-weigh the bad in many cases?

5. The Michigan Legislature passed a law forbidding the killing of hawks, owls and eagles, except that a farmer or landowner can destroy any such bird that is actually killing his poultry or livestock on land he owns or occupies. Students should learn to identify the kinds of hawks and owls that are common in Michigan and study their food habits. The National Audubon Society and the U. S. Department of Agriculture publish books, bulletins, and circulars on hawks and owls. (See reference list.)

6. Study the economic importance of fur bearers in the development of the state. Who were the first white residents of Michigan other than missionaries? What was their business? What animals attracted them to Michigan? Where were the fur trading posts of those days located? Why and when did the Michigan trading posts close down and move further West?

7. Study the habitat requirements (food and cover) of various fur bearers. (Refer to "Michigan Wildlife Sketches" for information.)

8. Discuss the life history of the whitetail deer. What are their food and cover requirements in summer? In winter? What is a "deer yard"? Why is winter a critical period for deer in northern Michigan?

9. Of what value are antlers to a male deer? Explain the difference between horns and antlers. What becomes of deer antlers after they are shed? What other Michigan animals bear antlers?

10. How does the doe deer care for her fawn? Is the fawn's coloration an aid in its protection? Should fawns lying quietly in the woods be picked up and taken home for pets? Is it legal to take fawns from the wild?

11. Discuss the reasons for having special antlerless deer seasons in some areas of the state. (Browsed-out deer yards and winter starvation, damage to orchards, nurseries, farm crops, and extensive highway hazard.)

12. Distinguish between warm water fishes and cold water fishes. List some examples of each.

13. Discuss the factors that affect fish populations: oxygen content of water, temperature, clarity of water and light penetration, aquatic vegetation, plankton organisms, pollution by domestic and industrial wastes, pollution by pesticides, siltation of stream beds, predators (including sea lamprey), competition for food and living space.

14. What is a food chain? Diagram and explain.

15. List the fishes that are not native to Michigan waters, but introduced. Examples: carp, brown and rainbow trout and salmon. Why are carp unpopular in this country and considered a valuable food fish in Europe?

16. Discuss the poisoning of certain lakes to reduce overpopulations of rough fish and stunted pan fish.

17. Why are all fishes poisoned out of some lakes and then the lakes replanted with trout or with pike, bass, and bluegills?

18. Why have closed seasons, size limits, and creel limits been removed in the case of bluegills, sunfish, crappie, rock bass, yellow perch, etc?

19. Discuss the role of pike, bass and other predaceous fishes in helping to maintain balanced fish populations in lakes.

20. Discuss the life history of the sea lamprey. View TV film, "Combatting the Sea Lamprey" available from the Department of Natural Resources.

21. Discuss the role of snakes, toads, and frogs in controlling insects and rodents.

22. Debate the pros and cons of the unregulated use of herbicides and pesticides for controlling weeds and insects. Reference: "Silent Spring" by Rachel Carson; magazine articles.

23. List some animals that hibernate during winter. Distinguish between those that truly hibernate and those that merely sleep during severe winter.

24. Discuss the migration of birds, and those that remain with us all winter and frequent our feeding stations. Also, list some that visit us only in winter and return to areas much further north for nesting in summer.

SUGGESTED ACTIVITIES:

1. Take bird walks with children in fall, winter, and spring. Post in the classroom a list of birds seen. Encourage children to identify and keep their own lists of birds seen in summer and at feeding stations in winter.

2. Encourage older children to build and erect bird houses for wrens and bluebirds as a class project. Specifications are available from the Department of Natural Resources. These may be erected on the school grounds if extensive enough to include an outdoor laboratory or an undeveloped area, in a school forest which should serve as an outdoor laboratory, or in the pupils' yards and gardens at home.

3. Show motion picture film, "Birds and Migration" available from the Department of Natural Resources.

4. Obtain copies of the Game Law Digest for class study and have children make lists of the game birds and mammals of the state. Find out which species they are familiar with. Have them collect pictures of upland game birds, waterfowl, big and small game mammals, and fur bearers. Such pictures can be found in old outdoor magazines, or they can be purchased (colored cards or wildlife stamps) from the National Wildlife Federation, 1412 Sixteenth St., N.W., Washington, D.C. 20036. Other sources of colored bird and animal pictures will be found in the reference list; the Department of Natural Resources cannot supply them.

5. Assign reference reading on game birds and mammals. Most school libraries have many children's books about animals and birds.

6. Have pupils prepare written or oral reports on different species of game birds and mammals, stressing their life histories (reproduction, food, shelter, habitat preferences, enemies, longevity) and distribution in Michigan.

7. Show films, "Michigan Mammals", "Nature's Engineer--The Beaver", "Know Your Ducks", "Michigan Marsh and Shore Birds", "The Woodducks' World", all available from the Department of Natural Resources.

8. Look for tracks of birds and mammals in snow, mud, or sand. Make field trips if practicable to study animal tracks. Refer to "Michigan Wildlife Sketches" for tracks of mammals. See reference list for this and other books on animal tracks.

9. Make plaster of Paris casts of animal tracks. Older children may wish to take pictures of the tracks.

10. Make a survey of the kinds and numbers of fur bearers that live in your community. In this connection, students can interview local fur buyers and trappers for information.

11. Set up a terrarium in the classroom or laboratory for displaying living specimens of small mammals, reptiles or amphibians. A good reference on the care and feeding of wild animals in captivity is entitled, "Our Small Native Animals--Their Habits and Care", by Robert Snediger, published in paperback by Dover Publications, Inc., New York, price: $1.75.

12. Visit a marsh, lake shore, or stream to look for tracks and other signs (muskrat houses, dens, nests, beaver cuttings or dams, etc.). Discuss the habits of the animals whose signs are discovered.

13. View the TV films, "Muskrat In Michigan--Parts I and II".

14. Arrange with a local farmer to visit his farm. Invite him to talk to the class about the wildlife on his land. Ask him whether he has made any attempt to maintain or improve his land for wildlife. Are there any swales, woods, or waste areas on the farm that could be retained or managed for wildlife? Discuss the possibilities for improving wildlife habitat. Ask him if he permits hunting on his land, and if he has suffered any damage from hunters.

15. Discuss the Horton Trespass Act. What legal procedures are necessary for enforcement of the law's provisions? Is it effective in controlling trespass?

16. Visit a deer yard, if practicable, in winter. Is there evidence of overbrowsing? What is a browse line?

17. In southern Michigan and in agricultural or orchard districts in the north, consult your local Conservation Officer or District Game Manager about deer damage complaints; also about the number of deer-car collisions that result in property damage and injury to drivers.

18. Discuss the need for deer herd control in southern Michigan as well as in the north.

19. Plot on outline maps of Michigan the areas of the state in which the following species occur: black bear, whitetail deer, elk, snowshoe hares, cottontail rabbits, pheasants, ruffed grouse, prairie chickens, sharptail grouse, and wild turkeys.

20. If practicable, organize a field trip to a state game area in southern Michigan. Look for evidence of habitat management for ruffed grouse, pheasants, waterfowl, fur bearers and cottontail rabbits. You may find small clearings, brush piles, food patches, areas planted with trees and shrubs to produce additional cover for wildlife, and large or small impoundments for waterfowl and fur bearers.

21. If you are situated in southern Michigan, organize a field trip to compare a pastured and an unpastured woodlot. Note the absence of game food and cover (seedling trees, fruit-bearing shrubs, vines, and herbs) in the pastured area, and how plentiful ground cover is in the unpastured area. List the birds and mammals that might be expected to live in the unpastured woodlot and not in the other. What is the ultimate fate of the pastured woodlot?

22. If you live in northern Michigan, make a similar comparison between a fairly mature pine forest and a brushy cut-over area, a beech-maple forest, or a swampy area.

23. If practicable, visit a trout stream. Look for deep pools and shallow riffles. Is the bottom gravelly or choked with sand and silt? Find out where the sand is coming from (steep under-cut banks, roadside ditches, banks broken down by livestock). Examine stones on the bottom for insect larvae (may flies, caddis flies, helgrammites, etc.) that provide food for trout. Is there any evidence of stream improvement work by the Department of Natural Resources such as log deflectors to narrow the stream and speed up the current, steep banks stabilized by sod or rock rip-rapping, fencing of streambanks to exclude livestock, planting of trees along the banks to shade the stream?

24. In more populous regions of the state, are there evidences of pollution in streams and rivers?

25. Arrange to visit industrial plants that use large quantities of water to find out what they have done to prevent polluted waste water from going back into the river or lake from which water is taken.

26. Arrange to visit a village or city sewage disposal plant. Find out how sewage is treated to insure that the effluent going into streams will not be harmful to fish, wildlife, and people.

27. Examine fishes in the classroom or laboratory. Learn the names of different fins. Note differences in the position of comparable fins in different species of fish. Compare the number of spines on the anal and dorsal fins of the bluegill and crappie, or whatever species are available. These are among the characteristics used in the classification of fishes.

28. Visit a farm pond and learn from the farmer whether or not it is stocked with fish and, if so, how much fishing it provides. How many pounds of fish it produces? If there are any problems involved in keeping it productive or fish life. For what other purposes is the farm pond used?

29. Arrange to show the motion picture films, "Lakes Trout & Tackle", "Commercial Fishing", or "Coho", all available from the Department of Natural Resources.

30. Demonstrate how to set up an aquarium. Use charcoal in the bottom to absorb impurities and odors; cover this with clean, washed sand; fill with clear well water or lake water (tap water from village or city water systems is likely to be chlorinated); allow sand to settle; plant aquatic vegetation to supply oxygen; introduce fish and snails; cover almost completely with glass to prevent evaporation. More elaborate systems with circulating water and temperature control are necessary for tropical fishes, but the simpler type stocked with small native fishes probably has greater educational value.

31. Arrange for a water safety program or demonstration. Many fishermen have drowned because they have been careless about the use of boats, or they have been caught out on a lake in storms. Someone from the Red Cross, Y.M.C.A., your county Sheriff's Department or your school's physical education department may serve as an instructor.

32. Also arrange with a local Conservation Officer for a hunting safety demonstration. Show motion pictures, "Hunting Safety" or "Shooting Safety", available from the Department of Natural Resources.

33. Have students keep records of the kinds and numbers of game birds and mammals seen on a highway that they ride over regularly, such as the school bus route. Highway kills on thousands of miles of roads in Michigan add up to significant losses of wildlife each year.

REFERENCES

The following books and bulletins are recommended (A) for teachers, and (B) for pupils. However, some of the references for teachers may not be too difficult for the better student readers.

Teachers will please note that the majority of the books and bulletins listed below must be ordered directly from the publishers. The Department of Natural Resources can supply only the bulletins and cirulars which it publishes and, even in this case, it cannot fill bulk orders for each member of a class. The best it can do is provide single copies for library use; duplication is permitted and encouraged.

Prices are generally omitted because they are subject to change without notice. In addition, you may find that some items are out of print by the time your order is received. This is a weakness of all bibliographies that cannot be avoided.

Geology: Rocks, Air, Water and Other Minerals

FOR TEACHERS

1. **Historical Geology**, by R. C. Hussey; McGraw-Hill Company.
2. **Fieldbook of Common Rocks and Minerals,** by F.B. Loomis; G.P. Putnam's Sons.
3. **Minerals of Might,** by Wm. O. Hotchkiss; Jacques Cattell Press.
4. **Minerals and World Affairs,** by T. S. Lovering; Prentice–Hall, Inc.
5. **Handbook of Paleontology For Beginners And Amateurs, Part I, The Fossils,** by Winifred Goldring; New York State Museum Handbook No. 9.
6. **School Program Materials,** a teacher's packet which includes bulletins, charts, and maps dealing with oil and petroleum products. Available from The Associated Petroleum Industries of Michigan, 118 1/2 West Ottawa Street, Lansing.
7. **A Primer On Water,** 50–page bulletin by Luna B. Leopold and W. B. Langbein; U. S. Geological Survey publication. Available from Superintendent of Documents, U. S. Government Printing Office, Washington, D.C., 35 cents per copy.
8. List of available Publications of the Geological Survey. Department of Natural Resources, Geological Survey Division, Lansing, Michigan 48926.

FOR INTERMEDIATE GRADES

1. **Rain Drops and Muddy Rivers,** by Mary Melrose, et al; National Wildlife Federation, 1412 Sixteenth Street, N. W., Washington D. C.

2. Basic Science Education Series; Row, Peterson & Company.

Stories Read From Rocks	**The Earth's Changing Surface**
The Earth, A Great Storehouse	**Life Through The Ages**
Water	**Our Ocean of Air**
Clouds, Rain and Snow	**Animals of Yesterday**

3. Basic Social Education Series; Row, Peterson & Company.

America's Minerals	**Buried Sunlight, The Story of Coal**
America's Oil	**Our Inland Seas, The Great Lakes**

4. American Education Press Unit Study Books.

No. 455, **Water: Sources and Uses**
No. 511, **Conservation of Soil and Water**
No. 308, **Story of Coal**
No. 353, **The Seasons**

5. **Geology,** by C. L. Cooper, et al; Boy Scouts of America, 25 cents.

6. **The Rock Book,** by C. L. Fenton; Doubleday, Doran & Company.

7. **Rocks and Their Stories,** by C. L. and M. A. Fenton; Doubleday, Doran & Co.

8. **Our Amazing Earth,** by C. L. Fenton; Doubleday, Doran & Company.

9. **Life Long Ago,** by C. L. Fenton; Reynal & Hitchcock.

10. **So That's Geology,** by R. R. Baker; Reilley & Lee Company.

11. **The Wonders of Water,** by Marian E. Baer; Ferrar and Rinehart.

12. **Water, Water Everywhere,** by Mary Welsh; Abingdon–Cokesbury Press.

13. **Exploring Earth and Space,** by Margaret Hyde; McGraw–Hill Book Company.

14. **Before and After Dinosaurs,** by Lois & Louis Darling; Wm. Morrow Co.

15. **The Story of Earth Science,** by H. G. Richards; J. B. Lippincott Co.

16. **Exploring the River,** by John & Jane Perry; Whittlesey House.

Soil Conservation And Land Use

FOR TEACHERS

1. **The Land Renewed,** by Van Dersal and Graham, Oxford University Press.

2. **Teaching Soil and Water Conservation, A Classroom and Field Guide,** Soil Conservation Service, U. S. Department of Agriculture, Washington, D. C.

3. **Things To Do In Science and Conservation,** by Ashbaugh and Beuschlein; The Interstate Printers and Publishers.

4. **Our Soils and Their Management,** by Roy L. Donahue; Interstate Printers and Publishers.

5. **Deserts On The March,** by Paul B. Sears; University of Oklahoma Press.

6. **Soil Conservation Workbook;** Interstate Printers and Publishers.

FOR INTERMEDIATE GRADE

1. **Our Daily Bread,** by Susan Myrick; Interstate Printers and Publishers.

2. **My Land and Your Land Series, National Wildlife Fed.,** 50 cents per copy.,

   Raindrops and Muddy Rivers, **Nature's Bank, The Soil,**

3. **Soil,** Basic Science Education Series; Row, Peterson & Company.

4. **This Is Our Soil,** by Walker & Foster, Interstate Printers & Publishers.

5. **Our Use of the Land,** by Brinser & Shepard, Harper Bros.

6. **Conquest of the Land Through 7,000 Years,** by W. C. Lowdermilk; Department of Agriculture, Information Bulletin No. 99. Single copy free.

7. Bulletins issued by Soil Conservation Service, Department of Agriculture.

   No. M-286, **What is Soil Erosion**
   No. M-294, **Farms The Rain Can't Take**
   No. M-449, **Early American Soil Conservationists**
   No. M-548, **Thomas Jefferson, Soil Conservationist**
   No. M-596, **Our American Land, The Story of Its Abuse and Conservation**
   No. 249, **What Is A Conservation Farm Plan?**

8. **Down The River,** Soil Conservation Society of America, Des Moines, Iowa. 10 cents per copy.

9. Other bulletins issued by the U. S. Department of Agriculture.

   Agr. Inf. Bulletin No. 78, **From The Dust of The Earth**
   Agr. Inf. Bulletin No. 95, **The Soil That Went to Town**

10. **Grass, Our Greatest Crop,** by Sarah R. Riedman; Thomas Nelson and Sons.

11. **Rocks, Rivers, and the Changing Earth,** by Herman & Nina Schneider; Wm. R. Scott, Inc.

12. **Good Health and Good Soil,** by Thompson & Green; Wm. C. Brown Company.

Trees, Woodlots And Forests

FOR TEACHERS

1. **Behold Our Green Mansions,** by R. H. D. Boerker; University of North Carolina Press.

2. **The Great Forest,** by R. G. Lillard; Alfred A. Knopf, Inc.

3. **Forest Conservation Packets for Teachers,** supplied by U. S. Forest Service, 710 N. Sixth St., Milwaukee, Wisc. and American Forest Products Industries, 1816 N. Street, N. W., Washington, D. C.

   Both of these packets contain a teacher's manual, bibliographies, bulletins, and colorful wall charts. Free on request from either agency, but not from the Conservation Department.

4. **Burning An Empire,** by Stewart Holbrook; The Macmillan Company.

5. **Conservation Handbook,** by National Association of Biology Teachers, Interstate Printers and Publishers.

6. Forest Service Bulletins and Visual Aids available from Office of Information, U.S. Department of Agriculture, Washington 25, D.C. Single copies are free to teachers, but some items may be out of print. Order by number and title.

BULLETINS

F–1492, **Arbor Day – Its Purpose and Its Observance**
M– 162, **Our Forests – What They Are and What They Mean To Us**
M– 290, **The Work of the U. S. Forest Service**
AIS– 67, **Know Your Watersheds**
AIS– 130, **Protecting Forests From Fire**

SERVICE CHARTS

D–4 **How A tree Grows,** (16"x21" colored)
D–5 **What We Get From Trees** (27"x39" colored)

MAPS (colored)

V–1 **Forest Trees and Forest Regions of the U.S.**
V–2 **National Forests of the U.S.**

BRIEF PAMPHLETS

K–3 **Care of Trees –– How to Revive Feeble or Weak Trees**
K– 4 **Christmas Trees**
K–26 **Why Leaves Change Their Color**
K–27 **Wood, The Material of a Thousand Uses**
O– 6 **Forest Insects and Diseases**
O– 7 **Forest Service Films** (a catalog)
O– 9 **Starting a Community Forest**
O–23 **What To Do When Lost in the Woods**
O–24 **How Our Forests Serve Us**
O–25 **Enemies of the Forest**
O–27 **Forests and Wildlife**
O–28 **Forests and Water**
O–37 **Visual and Auditory Aids for Teaching Conservation**
O–40 **Ranger 'Rithmetic** (for 6th grade)
O–41 **Ranger 'Rithmetic** (for 7th grade)

7. Bulletins and circulars available from Michigan Conservation Department. Free in limited quantities unless a price is indicated.

   Three Objectives of State Forest Management
   Simple Key for Tree Identification
   Commercial Woods of Michigan and Their Uses
   Trees Grow Where You Find Them
   History of State Forest Management
   Michigan State Forests (history and management)
   Forest Fires and Forest Fire Control in Michigan
   Motion Picture Catalog

8. **A Field Guide to Trees and Shrubs,** by George A. Petrides; Houghton-Mifflin Company.

9. **Illustrated Guide to Trees and Shrubs,** by A.H. Graves; Published by the author, Wellingford, Connecticut. $4.00.

10. **Lumbering Era In Michigan,** a film strip; purchase price $3.00; Audio-Visual Center, University of Michigan, Ann Arbor.

11. **American Wildlife and Plants** - A guide to wildlife food habits; McGraw-Hill Book Co. Also in paper back edition from Dover Publications, Inc.

FOR INTERMEDIATE GRADES

1. Basic Science Education Series; Row, Peterson & Company.

   Leaves
   Our American Forests; Today, Yesterday, and Tomorrow
   Flowers, Fruite and Seeds
   Fire, Friend or Foe
   Plants 'Round The Year
   Useful Plants and Animals
   Plant Factories
   Trees
   Plant World

2. My Land and Your Land Conservation Series, National Wildlife Federation. 50 cents per copy.

   Plants and Animals Life Together
   Would You Like To Have Lived Then?

3. **Thanks to Trees,** by Irma L. Webber; Wm. R. Scott, Inc.

4. **Tree On The Road To Turntown,** by Glenn Blough; Whittlesey House.

5. **Our Friend, The Forest,** by Patricia Lauber; Doubleday & Company.

Wildlife And Fishes

FOR TEACHERS

1. **Fading Trails,** by D. B. Beard; The Macmillan Company.

2. **Amateur Naturalist's Handbook,** by Vinson Brown; Little, Brown & Company.

3. **Sand County Almanac,** by Aldo Leopold; Oxford University Press.

4. **Our Wildlife Legacy,** by Durward L. Allen; Funk & Wagnalls.

5. **The Book of Bird Life,** by A. A. Allen; D. Van Nostrand Company.

6. **Enjoying Michigan Birds,** Michigan Audubon Society Bookshop, Kalamazoo College, Kalamazoo, Michigan--$1.25.

7. **Birds of Prey of Eastern North America,** by I . A. Housman; Rutgers University Press, New Brunswick, N. J.

8. **The Ducks, Geese, and Swans of North America,** by F. H. Kortright; The American Wildlife Management Institute, 709 Wire Bldg., Washington 5, D. C.

9. **How to Attract the Birds,** by R. S. Lemmon; Doubleday & Company.

11. **Hunters and The Hunted,** Cornell Rural School Leaflet Vol. 43, No. 3, 1949. Cornell University, Ithaca, N.Y.--10 cents.

12. **Bird Study for Schools,** by Roger T. Peterson (a series of leaflets), National Audubon Society, 1000 Fifth Avenue, New Nork. Single copies--10 cents; six or more, 5 cents each.

13. **Field Guide to Birds,** by Roger T. Peterson; Houghton-Mifflin Company.

14. **Mammals of the Great Lakes Region,** by Wm. H. Burt; University of Michigan Press, Ann Arbor.

15. **A guide to the Mammals,** by Wm. H. Burt; Houghton-Mifflin Company

16. **Meeting the Mammals,** by Victor H. Cahalane; The Macmillan Company.

17. **Land and Wildlife,** by Edward H. Graham; Oxford University Press.

18. **This Fascinating Animal World,** by Allan Devoe; McGraw-Hill Book Company.

FOR INTERMEDIATE GRADES

1. Basic Science Education Series; Row, Peterson & Company. Prices in quantities of five or more, 27 cents to 36 cents each.

Animals and Their Young
Animals That Live Together
Birds in Your Back Yard
Saving Our Wildlife
Useful Plants and Animals
Animals We Know
Animal Travels
Birds
Plant and Animal Partnership
Toads and Frogs
Reptiles
Adaptation to Environment
Balance In Nature

2. Children's Wildlife Books, National Wildlife Federation. Illustrated in color, 96 pages, price——$2.50 each; complete set of 5 books——$11.75.

Animal Babies
Friendly Animals
Homes and Habits of Wild Animals
Birds at Home
Traveling with Birds

3. True–to–Life Stories, by R. W. Eschmeyer, out of print, but may be available in school libraries.

Al Alligator
Billy Bass
Bob White
Bobby Bluegill
Charley Cottontail
Freddy Fox Squirrel
Mac Mallard
Tommy Trout
Willie Whitetail
Woody Woodcock

4. Little Wonder Books; Charles E. Merrill Company——15 cents each.

No. 105	**Animal Families**	No. 207	**Where Animals Live**
No. 410	**Color Protection**	No. 512	**Balance in Nature**

5. **Plants and Animals Live Together,** My Land and Your Land Series, National Wildlife Federation——50 cents.

6. **The Cottontail Rabbit,** by Elizabeth & Charles Schwartz; Holiday House.

7. **The Chisel Tooth Tribe,** by W. S. Bronson; Harcourt, Brace & Company.

8. **Horns and Antlers,** by W. S. Bronson; Harcourt, Brace & Company.

9. **Wild Folk at the Pond,** by Carroll L. Fenton; The John Day Company.

10. **Web of Nature,** by Ted Pettit; Garden City Publishing Company.

11. **Michigan Wildlife Sketches,** by Bradt & Schafer; Hillsdale Educational Publishers, P.O. Box 245, Hillsdale, Michigan.

12. **Partners With Nature,** by Ivah Green; International Textbook Company.

13. **The Tale of a Meadow,** by Henry B. Kane; Alfred A. Knopf Company.

14. **Wildlife in Danger,** by Ivah Green; Coward McCann Company.

15. **Strange Travelers,** by Sigmund Devine; Little, Brown & Company.

16. **The Tale of a Pond,** by Henry B. Kane; Alfred A. Knopf Company.

17. **All About Fish,** by Carl Burger; Random House.

18. **Animal Clocks and Compasses,** by Margaret O. Hyde; Whittlesey House.